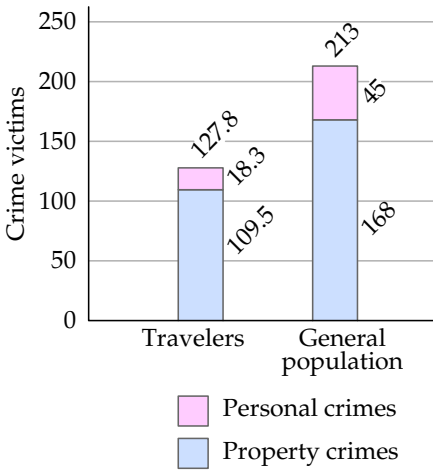


Crime Victims per 1000 Adults per Year

SOURCE: Travel Industry Association of America

52. **Crime Rates** According to a recent study, the crime rate against travelers in the United States is lower than that against the general population. The article reporting this study included a bar graph similar to the one at the left.

a. Why are the figures reported based on crime victims per 1000 adults per year?

b. Use the given figures to write the proportion

$$\frac{\text{personal crimes against travelers}}{\text{property crimes against travelers}} = \frac{\text{personal crimes against general population}}{\text{property crimes against general population}}$$

Is the proportion true?

c. Why might the crime rate against travelers be lower than that against the general population?

53. **The House of Representatives** The U.S. House of Representatives has a total of 435 members. These members represent the 50 states in proportion to each state's population. As stated in Article XIV, Section 2, of the Constitution of the United States, "Representatives shall be apportioned among the several states according to their respective numbers, counting the whole number of persons in each state."

U.S. House of Representatives

a. Find the population of each state according to the 2010 U.S. Census. Based on the state populations, determine how many representatives each state should elect to Congress.

b. Compare your list against the actual number of representatives that each state has.

SECTION 9.3 Percent

Percents

6% = 6/100

An understanding of percent is vital to comprehending the events that take place in our world today. We are constantly confronted with phrases such as "unemployment of 7%," "annual inflation of 4%," "6% increase in fuel prices," "25% of the daily minimum requirement," and "increase in tuition and fees of 10%."

Percent means "for every 100." Therefore, unemployment of 5% means that 5 out of every 100 people are unemployed. An increase in tuition of 10% means that tuition has gone up \$10 for every \$100 it cost previously.

POINT OF INTEREST

Of all the errors made on federal income tax returns, the four most common errors account for 76% of the mistakes. These errors include an omitted entry (30.7%), an incorrect entry (19.1%), an error in mathematics (17.4%), and an entry on the wrong line (8.8%).

QUESTION When adults were asked to name their favorite cookie, 52% said chocolate chip. What does this statistic mean? (*Source:* WEAREVER)

A percent is a ratio of a number to 100. Thus $\frac{1}{100} = 1\%$, $\frac{50}{100} = 50\%$, and $\frac{99}{100} = 99\%$. Because $1\% = \frac{1}{100}$ and $\frac{1}{100} = 0.01$, we can also write 1% as 0.01.

$$\mathbf{1\% = \frac{1}{100} = 0.01}$$

The equivalence $1\% = 0.01$ is used to write a percent as a decimal or to write a decimal as a percent.

ANSWER 52 out of every 100 people surveyed responded that their favorite cookie was chocolate chip. (In the same survey, the following responses were also given: oatmeal raisin, 10%; peanut butter, 9%; oatmeal, 7%; sugar, 4%; molasses, 4%; chocolate chip oatmeal, 3%.)

MATH

College Graduates' Job Expectations

The table below compares the expectations of 2015 college graduates with the realities of those who graduated in 2013 or 2014. (*Source:* Accenture)

Expectations of 2015 graduates	Realities of 2013–2014 graduates
80% believed their education prepared them well	64% felt their education prepared them well
72% completed an internship, apprenticeship, or co-op	47% found a job as a result of an internship, apprenticeship, or co-op
82% considered job availability before selecting a major	64% are working in their chosen field
85% expect to earn more than $25,000 per year	59% earn more than $25,000 per year

Percent Problems: The Proportion Method

Finding the solution of an application problem involving percent generally requires writing and solving an equation. Two methods of writing the equation will be developed in this section—the *proportion method* and the *basic percent equation*. We will present the proportion method first.

The proportion method of solving a percent problem is based on writing two ratios. One ratio is the percent ratio, written $\frac{\text{percent}}{100}$. The second ratio is the amount-to-base ratio, written $\frac{\text{amount}}{\text{base}}$, where the *base* is the number that the percentage will be taken of, and the *amount* is the result after the percentage is taken. These two ratios form the proportion used to solve percent problems.

The Proportion Used to Solve Percent Problems

$$\frac{\text{percent}}{100} = \frac{\text{amount}}{\text{base}}$$

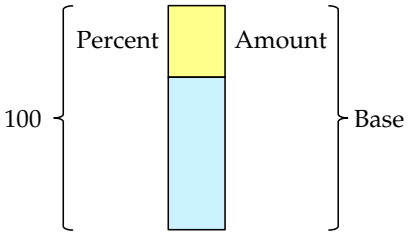


Diagram of the Proportion Method of Solving Percent Problems

The proportion method can be illustrated by a diagram. The rectangle at the left is divided into two parts. On the left, the whole rectangle is represented by 100 and the part by percent. On the right, the whole rectangle is represented by the base and the part by the amount. The ratio of percent to 100 is equal to the ratio of the amount to the base.

When solving a percent problem, first identify the percent, the base, and the amount. It is helpful to know that the base usually follows the phrase "percent of."

QUESTION In the statement "15% of 40 is 6," which number is the percent? Which number is the base? Which number is the amount?

ANSWER The percent is 15. The base is 40. (It follows the phrase "percent of.") The amount is 6.

EXAMPLE 5 Solve a Percent Problem for the Base Using the Proportion Method

The average size of a new single-family house in 2014 was 2690 ft^2. This is 158% of the average size of a new house in 1980. What was the average size of a new house in 1980? Round to the nearest whole number.

Solution

We want to answer the question "158% of what number is 2690?" Write and solve a proportion. The percent is 158%. The amount is 2690. The base is the average size of a new house in 1980.

$$\frac{\text{percent}}{100} = \frac{\text{amount}}{\text{base}}$$

$$\frac{158}{100} = \frac{2690}{x}$$

Cross multiply. $269000 = 158x$

Divide 158. $\$\ 1702.53 = x$

The average size of a new house in 1980 was 1703 ft^2.

Take 5 minutes to do Check for Progress 5.

CHECK YOUR PROGRESS 5 A used Toyota Corolla was purchased for $12,950. This is 70% of the cost when new. What was the cost of the Toyota Corolla when it was new?

$$\frac{70}{100} = \frac{12950}{x}$$

$1295000 = 70x$

$18500 = x$

Cross multiply. Divide 70.

Solution See page S31.

EXAMPLE 6 Solve a Percent Problem for the Percent Using the Proportion Method

POINT OF INTEREST

According to the U.S. Department of Agriculture, of the 430 billion pounds of food produced annually in the United States, about 133 billion pounds are wasted. This is approximately 31% of all the food produced in the United States.

According to the Bureau of Labor Statistics, in a recent year the average American family had an income of $66,877 and spent $6759 on food. What percent of the family income was spent on food? Round to the nearest percent.

Solution

We want to answer the question "What percent of $66,877 is $6759?" Write and solve a proportion. The base is $66,877. The amount is $6759. The percent is unknown.

$$\frac{\text{percent}}{100} = \frac{\text{amount}}{\text{base}}$$

$$\frac{x}{100} = \frac{6759}{66877}$$

Cross multiply. $66877x = 675900$

Divide 66877. $x = 10.11\% \rightarrow 10\%$

Ten percent of the family income was spent on food.

CHECK YOUR PROGRESS 6

An estimated 43.5 million adults in the United States are caretakers for an older friend or relative. Of these adults, 18.705 million said they feel they did not have a choice in this role. What percent of the adult caretakers in the United States feel they did not have a choice in this role? (*Source:* TIME, February 1, 2010)

Solution See page S31.

EXAMPLE 7 **Solve a Percent Problem for the Amount Using the Proportion Method**

Thirty-two percent of the world population of 7.3 billion people do not have access to improved sanitation facilities. How many people worldwide do not have access to improved sanitation facilities? (*Source:* World Health Organization, Fact Sheet No. 392, June 2015)

Solution

We want to answer the question, "32% of 7.3 billion is what number?" Write and solve a proportion. The percent is 32%. The base is 7.3 billion. The amount is the number of people who do not have access to improved sanitation facilities.

$$\frac{\text{percent}}{100} = \frac{\text{amount}}{\text{base}}$$

$$\frac{32}{100} = \frac{x}{7.3 \text{ billion}}$$

Cross multiply. $100x = 233.6$ billion

Divide 100. $x = 2.336$ billion

About 2.34 billion people worldwide do not have access to improved sanitation facilities.

CHECK YOUR PROGRESS 7 A General Motors buyer incentive program offered a 3.5% rebate on the selling price of a new car. What rebate would a customer receive who purchased a $32,500 car under this program?

Solution See page S32.

Percent Problems: The Basic Percent Equation

A second method of solving a percent problem is to use the basic percent equation.

The Basic Percent Equation

$PB = A$, where P is the percent, B is the base, and A is the amount.

When solving a percent problem using the proportion method, we have to first identify the percent, the base, and the amount. The same is true when solving percent problems using the basic percent equation. Remember that the base usually follows the phrase "percent of."

When using the basic percent equation, the percent must be written as a decimal or a fraction. This is illustrated in Example 8.

EXAMPLE 8 Solve a Percent Problem for the Amount Using the Basic Percent Equation

A real estate broker receives a commission of 3% of the selling price of a house. Find the amount the broker receives on the sale of a $275,000 home.

Solution

We want to answer the question "3% of $275,000 is what number?" Use the basic percent equation. The percent is 3% = 0.03. The base is 275,000. The amount is the amount the broker receives on the sale of the home.

$$PB = A$$
$$0.03(275{,}000) = A$$
$$8250 = A$$

The real estate broker receives a commission of $8250 on the sale.

CHECK YOUR PROGRESS 8 New Hampshire public school teachers contribute 5% of their wages to the New Hampshire Retirement System. What amount is contributed during one year by a teacher whose annual salary is $46,875?

Solution See page S32.

means "translate the sentence into math"

EXAMPLE 9 Solve a Percent Problem for the Base Using the Basic Percent Equation

An investor received a payment of $480, which was 12% of the value of the investment. Find the value of the investment.

$480 = \left(\frac{12}{100}\right)(x)$

Solution

We want to answer the question "12% of what number is 480?" Use the basic percent equation. The percent is 12% = 0.12. The amount is 480. The base is the value of the investment.

$PB = A$

$480 = 0.12x$

Divide 0.12

$4000 = x$

Check the answer makes sense. Here $4000 > 480$, which makes sense.

The value of the investment is $4000.

CHECK YOUR PROGRESS 9 A real estate broker receives a commission of 3% of the selling price of a house. If the broker receives a commission of $14,370 on the sale of a home, what was the selling price of the home?

$0.03x = 14370$

$x = 479000$

Solution See page S32.

3% of selling price is commission.

$3/100 * (x) = (14370)$

EXAMPLE 10 Solve a Percent Problem for the Percent Using the Basic Percent Equation

If you answer 96 questions correctly on a 120-question exam, what percent of the questions did you answer correctly?

Solution

We want to answer the question "What percent of 120 questions is 96 questions?" Use the basic percent equation. The base is 120. The amount is 96. The percent is unknown.

what percent of the questions did you answer correctly

$\frac{x}{100} * 120 = 96$

simplify left

$1.2x = 96$

divide 1.2

$x = 80$

80%

80

You answered 80% of the questions correctly.

CHECK YOUR PROGRESS 10 If you answer 63 questions correctly on a 90-question exam, what percent of the questions did you answer correctly?

Solution See page S32.

cappi thompson/Shutterstock.com

The table below shows the average cost in the United States for five of the most popular home remodeling projects and the average percent of that cost recouped when the home is sold. Use this table for Example 11 and Check Your Progress 11. (*Source:* cgi.money.cnn.com)

Home remodeling project	Average cost	Percent recouped
Addition to the master suite	$94,331	72%
Major kitchen remodeling	$54,241	80%
Home office remodeling	$20,057	63%
Bathroom remodeling	$12,918	85%
Basement remodeling	$56,724	79%

EXAMPLE 11 Solve an Application Using the Basic Percent Equation

Find the difference between the cost of remodeling the basement of your home and the amount by which the remodeling increases the sale price of your home.

Solution

The cost of remodeling the basement is $56,724, and the sale price increases by 79% of that amount. We need to find the difference between $56,724 and 79% of $56,724.

Use the basic percent equation to find 79% of $56,724. The percent is 79% = 0.79. The base is 56,724. The amount is unknown.

$$PB = A$$
$$0.79(56{,}724) = A$$
$$44{,}811.96 = A$$

Subtract 44,811.96 (the amount of the cost that is recouped when the home is sold) from 56,724 (the cost of remodeling the basement).

$$56{,}724 - 44{,}811.96 = 11{,}912.04$$

The difference between the cost of remodeling the basement and the increase in the value of your home is $11,912.04.

POINT OF INTEREST

According to Sallie Mae's *How America Pays for College* report, 54% of college students lived at home in 2014. That's up from 43% in 2010.

CHECK YOUR PROGRESS 11

Find the difference between the cost of a major kitchen remodeling in your home and the amount by which the remodeling increases the sale price of your home.

Solution See page S32.

Percent Increase

When a family moves from one part of the country to another, they are concerned about the difference in the cost of living. Will food, housing, and gasoline cost more in that part of the country? Will they need a larger salary in order to make ends meet?

We can use one number to represent the increased cost of living from one city to another so that no matter what salary you make, you can determine how much you will need to earn in order to maintain the same standard of living. That one number is a percent.

For example, look at the information in the table below. (*Source:* http://cgi.money.cnn.com/tools/costofliving/)

If you live in	and are moving to	you will need to make this percent of your current salary
Cincinnati, Ohio	San Francisco, California	191
St. Louis, Missouri	Boston, Massachusetts	153
Denver, Colorado	New York, New York	207

A family in Cincinnati living on \$60,000 per year would need 191% of their current income to maintain the same standard of living in San Francisco. Likewise, a family living on \$150,000 per year would need 191% of their current income.

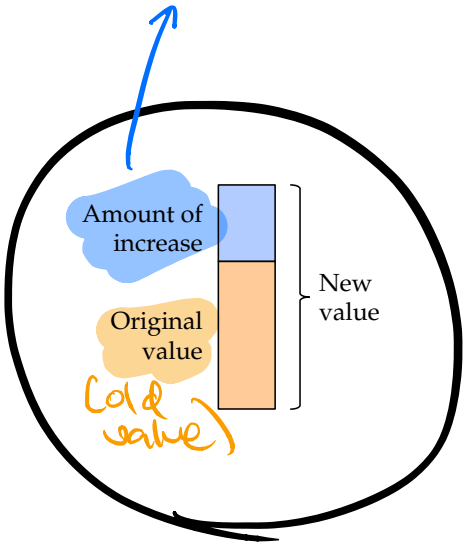
$60{,}000(1.91) = 114{,}600 \qquad 150{,}000(1.91) = 286{,}500$

The family from Cincinnati living on \$60,000 would need an annual income of \$114,600 in San Francisco to maintain their standard of living. The family living on \$150,000 would need an annual income of \$286,500 in San Francisco to maintain their standard of living. No matter what a family's present income, they can use 191% to determine their necessary comparable income.

QUESTION How much would a family in Denver, Colorado, living on \$55,000 per year need in New York City to maintain a comparable lifestyle? Use the table above.

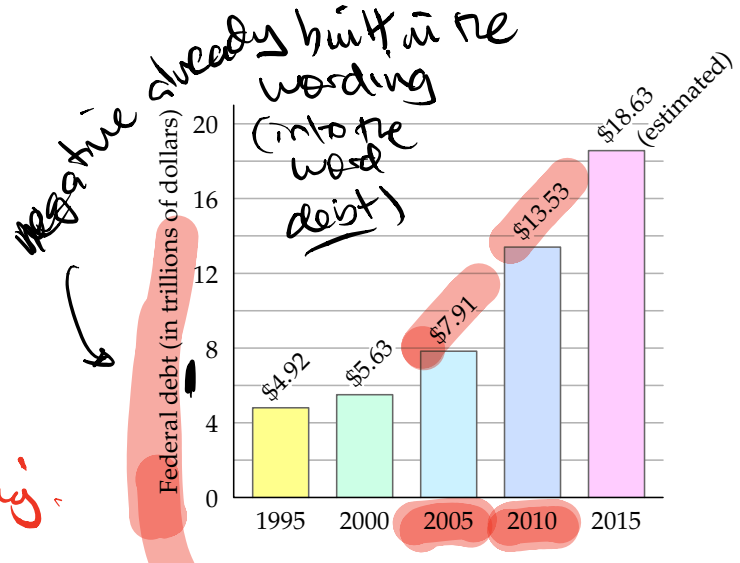
The cost of living in San Francisco is 191% of the cost of living in Cincinnati; this means that a family moving from Cincinnati to San Francisco will see a 91% *increase* in their cost of living. **Percent increase** is used to show how much a quantity has increased over its original value. Statements that illustrate the use of percent increase include "sales volume increased by 11% over last year's sales volume" and "employees received an 8% pay increase."

The **federal debt** is the amount the government owes after borrowing the money it needs to pay for its expenses. It is considered a good measure of how much of the



ANSWER In New York City, the family would need \$55,000(2.07) = \$113,850 per year to maintain a comparable lifestyle.

government's spending is financed by debt as opposed to taxation. The graph below shows the federal debt at the end of the fiscal years 1995, 2000, 2005, 2010, and 2015. A fiscal year is the 12-month period that the annual budget spans, from October 1 to September 30. Use the graph for Example 12 and Check Your Progress 12.



SOURCE: www.whitehouse.gov

EXAMPLE 12 **Solve an Application Involving Percent Increase**

Find the percent increase in the federal debt from 2005 to 2010. Round to the nearest tenth of a percent.

Solution

Calculate the amount of increase in the federal debt from 2005 to 2010.

$$13.53 - 7.91 = 5.62$$

We will use the basic percent equation. (The proportion method could also be used.) The base is the debt in 2005. The amount is the amount of increase in the debt. The percent is unknown.

The percent increase in the federal debt from 2005 to 2010 was 71.0%.

CHECK YOUR PROGRESS 12

Find the percent increase in the federal debt from 1995 to 2015. Round to the nearest tenth of a percent.

Solution See page S32.

Notice in Example 12 that the percent increase is a measure of the *amount of increase* over an *original value*. Therefore, in the basic percent equation, the amount A is the *amount of increase* and the base B is the *original value*, in this case the debt in 2005.

HISTORICAL

The largest percent increase, for a single day, in the Dow Jones Industrial Average occurred on March 15, 1933. The Dow gained approximately 15% of its value.

Percent Decrease

The federal debt is not the same as the federal deficit. The **federal deficit** is the amount by which government spending exceeds the federal budget. The table below shows projected federal deficits. (*Source:* www.usgovernmentspending.com)

Year	Federal deficit (in billions of dollars)
2010	$1294
2011	$1300
2012	$1087
2013	$680
2014	$485
2015	$439

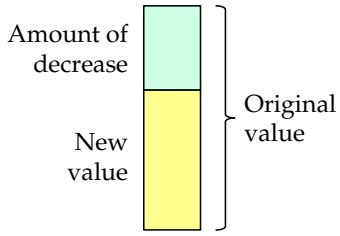
Note that the deficit listed for 2013 is less than the deficit listed for 2012. This decrease can be expressed as a percent. First find the amount of decrease in the deficit from 2012 to 2013.

$$1087 - 680 = 407$$

We will use the basic percent equation to find the percent. The base is the deficit in 2012. The amount is the amount of decrease.

$$PB = A$$
$$P \cdot 1087 = 407$$
$$\frac{P \cdot 1087}{1087} = \frac{407}{1087}$$
$$P \approx 0.374$$

The federal deficit decreased by 37.4% from 2012 to 2013.



The percent used to measure the decrease in the federal deficit is a *percent decrease*. **Percent decrease** is used to show how much a quantity has decreased from its original value. Statements that illustrate the use of percent decrease include "the president's approval rating has decreased 9% over last month" and "there has been a 15% decrease in the number of industrial accidents."

Note in the deficit example above that the percent decrease is a measure of the *amount of decrease* over an *original value*. Therefore, in the basic percent equation, the amount A is the *amount of decrease* and the base B is the *original value,* in this case the deficit in 2012.

Look at this one

EXAMPLE 13 Solve an Application Involving Percent Decrease

According to the National Highway Traffic Safety Administration, there were 4668 deaths from motorcycle accidents in 2013 while there were 4986 deaths in 2012. This decrease reverses a rising trend from previous years. Find the percent decrease in deaths due to motorcycle accidents from 2012 to 2013. Round to the nearest tenth of a percent.

Solution

First find the amount of decrease.

$$4986 - 4668 = 318$$

3. Dee Pinckney is married and filing jointly. She has an adjusted gross income of $58,120. The W-2 form shows the amount withheld as $7124. Find Dee's tax liability and determine her tax refund or balance due.
4. Jeremy Littlefield is single and has an adjusted gross income of $152,600. His W-2 form lists the amount withheld as $36,500. Find Jeremy's tax liability and determine his tax refund or balance due.
5. Does a taxpayer in the 33% tax bracket pay 33% of his or her earnings in income tax? Explain your answer.
6. In the table for single taxpayers, how were the figures $922.50 and $5156.25 arrived at?

EXERCISE SET 9.3

1. Name three situations in which percent is used.
2. Multiplying a number by 300% is the same as multiplying it by what whole number?

Complete the table of equivalent fractions, decimals, and percents.

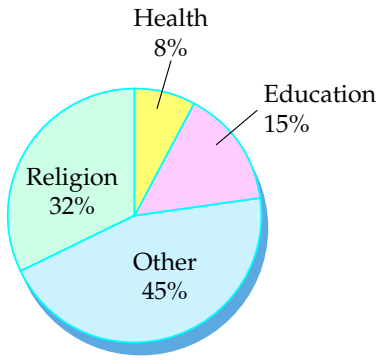
	Fraction	Decimal	Percent
3.	$\frac{1}{2}$		
4.		0.75	
5.			40%
6.	$\frac{3}{8}$		
7.	$\frac{7}{10}$	0.7 =	70%
8.	$\frac{5625}{10000}$	0.5625 ← move decimal 2 times	56.25%
9.	$\frac{11}{20}$ → calculator	0.55	55%
10.		0.52	
11.			15.625%
12.	$\frac{9}{50}$		

90% of 132 million
90 ÷ 100 * 132 million
= 118.8 million
119 million

13. **e-Filed Tax Returns** The IRS reported that as of April 17, 2015, it had received 132 million tax returns for 2014. Of these, 90% were filed electronically. How many of the returns were filed electronically? Round to the nearest million.

14. **Credit Cards** A credit card company offers an annual 2% cash-back rebate on all gasoline purchases. If a family spent $6200 on gasoline purchases over the course of a year, what was the family's rebate at the end of the year?

15. **Charitable Contributions** During a recent year, charitable contributions in the United States totaled $358 billion. The graph at the right shows to whom this money was donated. Determine how much money was donated to educational organizations. (*Source:* Giving USA Foundation)



Recipients of Charitable Contributions in the United States

16. **Television** A survey by the *Boston Globe* questioned elementary and middle-school students about television. Sixty-eight students, or 42.5% of those surveyed, said that they had a television in their bedroom at home. How many students were included in the survey?

17. **Motorists** A survey of 1236 adults nationwide asked, "What irks you most about the actions of other motorists?" The response "tailgaters" was given by 293 people. What percent of those surveyed were most irked by tailgaters? Round to the nearest tenth of a percent. (*Source:* Reuters/Zogby)

18. **Wind Energy** In a recent year, wind machines in the United States generated 181.7 billion kWh of electricity, enough to serve over 16 million households. The nation's total electricity production that year was 4094 billion kWh. (*Source:* Energy Information Administration) What percent of the total energy production was generated by wind machines? Round to the nearest tenth of a percent.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90% of 132 million
90 ÷ 100 * 132 million
= 118.8 million
119 million

13. e-Filed Tax Returns The IRS reported that as of April 17, 2015, it had received 132 million tax returns for 2014. Of these, 90% were filed electronically. How many of the returns were filed electronically? Round to the nearest million.

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14. Credit Cards A credit card company offers an annual 2% cash-back rebate on all gasoline purchases. If a family spent $6200 on gasoline purchases over the course of a year, what was the family's rebate at the end of the year?

Find 2% of $6200.

2/100 • 6200

124

We solved these using the basic percent equation (p 527